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DETROIT

RESEARCH ADVISORY SERVICE ON INFORMATION PROCESSING

A Research Information Center and Advisory Service on Information Processing, to be operated jointly by the National Bureau of Standards and the National Science Foundation, has been established at the Bureau.

The new Service is designated to bring together research and development data on methods and equipment for the automatic processing of scientific information. It is further designed to foster closer cooperation among groups in industry, private foundations, universities, professional societies, and the Federal Government concerned with developing and improving methods for rapid and efficient handling of large volumes of information.

Initiation of the Service is a part of a broad program being developed by the National Science Foundation to improve the quality of scientific information services and shorten the time spent by scientists in searching the literature. Other phases of the broad program include the support of scientific publications, translations of foreign scientific literature, and support of information and data-processing centers.

The Foundation has made a grant of $105,000 to the Bureau for the establishment and first year's operation of the Service, and will establish policies for its use. The Service will be staffed by Bureau personnel, who will analyze materials received and furnish requested technical advice. The Council on Library Resources has contributed $20,000 toward operating costs during the first 2 years. The Council, which supports research on library problems, was established in 1956 with the financial support of the Ford Foundation.

During the first 6 to 9 months, the Service will assemble and organize available research and development data on methods and equipment for the automatic processing of information expressed in words, diagrams, or other nonnumerical forms. Continuing tasks, to be begun as rapidly as possible, will be to:

1. Explore known sources and locate undeveloped sources of information on current research and development activities.

2. Establish and maintain a central reference file of information on current projects, researchers, and publications in the field. Descriptive information on work in progress will continue to be published in the Foundation's semiannual report on "Current Research and Development in Scientific Documentation".

3. Follow developments closely, analyze collected information, and from time to time prepare and publish reviews of progress.

4. Test and compare various procedures and techniques for the manipulation or searching of information.

5. Provide Federal agencies and cooperating private organizations with requested technical advice on information processing problems and on proposed research in the field. The Service will not undertake to evaluate research proposals, but will furnish advice on the relation of proposed programs of research to other activities in progress and will suggest specialists believed to be particularly well-qualified to evaluate proposed research.

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Eventually, it is hoped the Service will be able to provide cooperating private organizations and Federal agencies with consulting services regarding the use of machines as aids in research on information processing, the availability of machine facilities for testing theories and techniques, and the availability for research purposes of texts and other source data in a form suitable for machine processing.

Examples of specific areas of investigation with which the Service will be concerned are:

(a) Theoretical studies of information storage and retrieval.

(b) Mechanization of procedures included in the processing of information for storage and retrieval and in the planning and conduct of searches—for example, research on mechanical or semimechanical indexing, word correlation, and abstracting or condensation, and on search strategies and techniques.

(c) Methods of using natural language, or some normalized form of natural language, for mechanized storage and retrieval systems.

(d) Development and evaluation of mechanized storage and retrieval systems.

(e) Machine translation from one natural language into another.

(f) Automatic pattern recognition, searching, and identification (of patterns such as electronic circuit diagrams and chemical structure diagrams).

(g) Development and testing of equipment for accomplishing any of the preceding tasks.

Organizations and individuals engaged in research and development activities or planning programs in these areas, may request further information about the new Service and the procedures to be followed in requesting advice or information, by addressing their queries to the Research Information Center and Advisory Service on Information Processing, Program for Documentation Research, National Science Foundation, Washington 25, D. C.

RUBIDIUM VAPOR MAGNETOMETER

A SIMPLE, compact magnetometer having significant advantages over previous instruments of this kind has been developed by T. L. Skillman of the U. S. Coast and Geodetic Survey, and P. L. Bender of the National Bureau of Standards.[1] The instrument measures extremely small magnetic fields with great accuracy by locating very narrow Zeeman absorption lines in rubidium vapor. Measurements of the earth's magnetic field made in this way differ by about 6 γ (1 $\gamma = 10^{-5}$ gauss) from the value in terms of the international magnetic standard.

Rubidium vapor magnetometer alined with the earth's magnetic field. Rubidium light source (upper end) and photocell detector (lower end) are placed at fairly large distances from the rubidium vapor cell (center) in this preliminary model because they contain magnetic components that would affect the measurement.

The high sensitivity, stability, and potentially small size of the rubidium vapor magnetometer make it particularly well suited for use in rockets and satellites. In comparison with the proton precession magnetometer, which has already been used in such applications,[2] the present instrument is much more effective in measuring very weak fields. Its stability is, of course, superior to that of magnetometers whose action depends on moving magnets, and is also better than that of induction-type instruments.

The rubidium vapor magnetometer makes use of the fact that the absorption of polarized light in rubidium vapor depends on the orientation of the rubidium atoms.[3] When circularly polarized light of a particular wavelength is passed through rubidium vapor, atoms are "pumped out" of orientations where absorption is high. The final result is "optical pumping" from high-absorption to low-absorption orientation as atoms returning from the excited state tend to accumulate in the lower absorption orientations.

In a radiofrequency field, rubidium vapor displays absorption lines at its Zeeman transition frequencies—the frequencies into which a normal emission line is split by a magnetic field. As the Zeeman transitions correspond to changes in atomic orientation, their

frequencies can be determined by observing changes in the absorption of polarized light in the vapor. Since the magnetic field is related to the transition frequencies by accurately known constants, an accurate measurement of field can be conveniently made in this way.

The rubidium vapor magnetometer consists of an absorption cell containing rubidium vapor and an inert buffer gas, and a rubidium lamp whose output is circularly polarized by a polaroid sheet and a quarter-wave plate. Light from the lamp is filtered so that only the strong optical line at 7947A enters the vapor. The amount of light transmitted is monitored by a photocell.

The magnetometer is oriented in the field to be measured so that the light beam is roughly parallel to the magnetic field. The optical pumping effect causes the atoms in the vapor to line up with the field. Thus, the amount of light absorbed is less than if the atoms were randomly oriented.

An rf field is then applied at right angles to the original field, causing the atoms to change their orientations. The rf frequency is varied, and when the transition frequencies are reached light is absorbed in greater amounts than when the atoms were alined. Thus, the transition frequencies are observed as dips in the photocell output.

In determining the earth's magnetic field by this method, six Zeeman lines spread over a range of 1.7 kc were observed. Relating the frequencies of these lines (the frequencies at which photocell output dipped) to the magnetic field, yielded a value which disagrees somewhat with the accepted value obtained with the Fredericksburg Magnetic Observatory magnetograph. The magnetometer measurement has an absolute accuracy of about 2 γ. Work being carried out at the Observatory is expected to increase this accuracy considerably.

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[1] *For further details, see* Measurement of the earth's magnetic field with a rubidium vapor magnetometer, *by T. L. Skillman and P. L. Bender, J. Geophys. Research* **63,** *513 (September 1958).*

[2] The earth's magnetic field above WSPG, New Mexico, from rocket measurements, *by J. P. Heppner, J. D. Stolarik, and L. H. Meredith, J. Geophys. Research* **63,** *277 (June 1958).*

[3] Slow spin relaxation of optically polarized sodium atoms, *by H. G. Dehmelt Phys. Rev.* **105,** *1487 (March 1, 1957).*

HUNTOON APPOINTED DEPUTY DIRECTOR

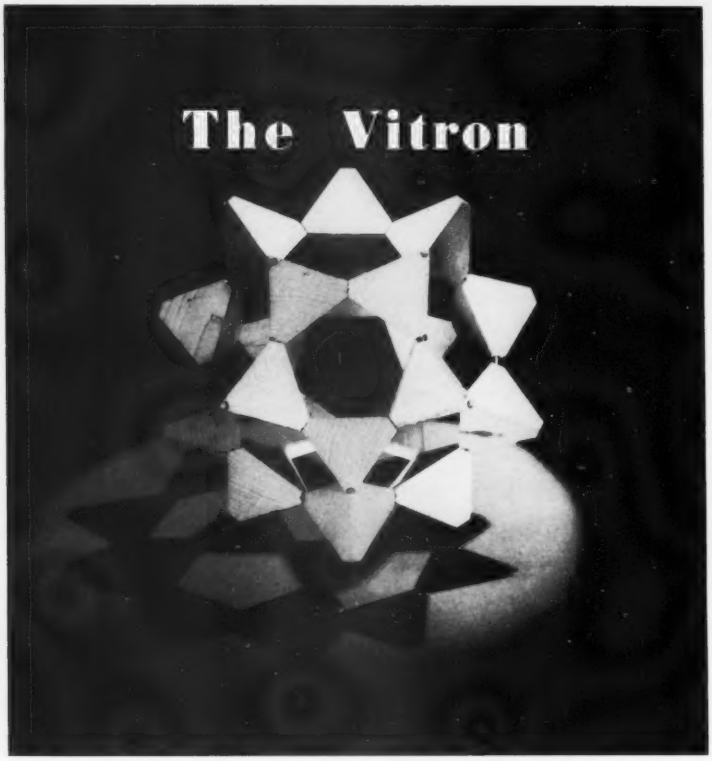
DR. ROBERT D. HUNTOON has been appointed to the newly created position of Deputy Director of the National Bureau of Standards. In this post, he will serve as alternate to the Director in external matters, and will exercise day-to-day direction and review of Bureau programs, working through the Associate Directors for Engineering, Chemistry, the Boulder (Colorado) Laboratories, Planning, and Administration. He will continue to serve as Associate Director for Physics.

Dr. Huntoon joined the Bureau staff in 1941, as one of the principal scientists concerned with the development of the radio proximity fuze, considered by many to be second in importance only to the atomic bomb among World War II scientific achievements. Since then he has been, at various times, Chief of the Electronics Division, Chief of the Atomic and Radiation Physics Division, Acting Chief of the Central Radio Propagation Laboratory, Coordinator of the AEC projects at the Bureau, and Director of the NBS Corona (California) Laboratories, which are now operated by the Navy Bureau of Ordnance. In 1953, Dr. Huntoon was appointed Associate Director for Physics.

In a wide and varied career, Dr. Huntoon has conducted or supervised research and engineering in numerous fields, including atomic beams, nuclear physics, microwave measurement, guided missiles, digital computers, and fundamental physical constants. He is currently serving as Chairman of a House Appropriations Committee study group investigating problems of reliability in weapons systems.

Born in Waterloo, Iowa, in 1909, Dr. Huntoon earned his B. A. in physics from Iowa State Teachers College in 1932, and his M. A. and Ph.D. from the State University of Iowa in 1935 and 1938, respectively. Prior to coming to the Bureau, he taught physics at New York University and was a research physicist with the vacuum tube division of Sylvania Electric Products, Inc.

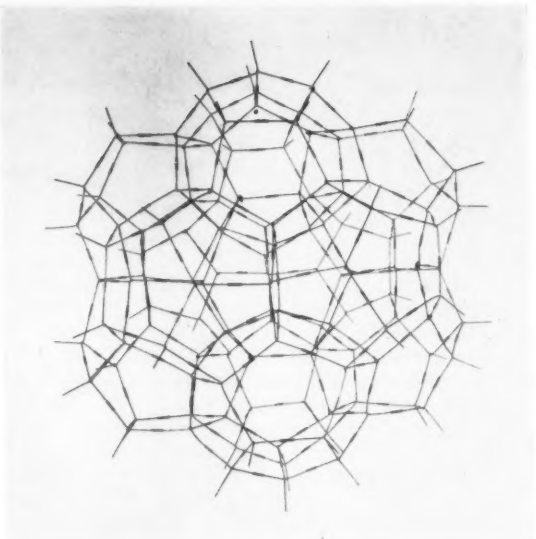
Dr. Huntoon has received a Presidential Certificate of Merit and a Department of Commerce Exceptional Service Award for his Variable Time (Radio Proximity) fuze contributions, the Washington Academy of Sciences Award in Physical Sciences, Certificates of Appreciation from the Office of Scientific Research and Development, War Department, and Secretary of War, a Naval Ordnance Development Award for contributions to Electronic Ordnance, and an Achievement Award from the Alumni of Iowa State Teachers College. He is a Fellow of the Institute of Radio Engineers and the American Physical Society, and a member of the Washington Academy of Sciences, Philosophical Society of Washington, Sigma Xi, and Kappa Delta Pi.



A NEW CONCEPT of the atomic structure of matter in the glassy state has been suggested by L. W. Tilton of the Bureau. Based on a structural unit called the "vitron", this concept envisions a noncrystal yet systematic arrangement of atoms over submicroscopic volumes.[1] Such a structure is in accord with available data on the unique properties of glass which set it apart from other types of substances.

The vitron is conceived as a submicroscopic cluster of pentagonal dodecahedra with subunits of silicon-oxygen tetrahedra. Because of their pentagonal shape, the dodecahedra can be fitted together only when slightly distorted, and this ultimately limits the size of the cluster. In the proposed model, the clusters are somewhat loosely joined together by "connective tissues" that have weaker bonds but greater densities than the vitron. This new concept, if corroborated, would help to reconcile current hypotheses on the structural differences between the glassy and crystalline states.

Above: **View along fivefold axis of a single-element vitron constructed of 20 tetrahedra representing 20 silicon atoms at their centers and 30 oxygen atoms at their connected corners. The vitron is the basic structural element in a new concept proposed at the Bureau for studying the structure of glass. This picture, taken by William S. Smallwood of the photographic laboratory, received honorable mention in the "general class" at the ASTM 1958 Photographic Exhibit. Other award-winning photographs on pages 242 and 243.**



View along one axis of a 13-element vitron model. In this model, a tetrahedron is represented by two wires bent at an angle of 109.5° and soldered at the wires' symmetrical crossing to represent silicon.

The extent of orderly arrangement in the vitron concept is greater than in other hypotheses but some randomness is retained, especially in the regions where connective tissues unite the clusters. To a certain degree, this noncrystal concept is equivalent to the "crystallite" hypothesis as stated by Randall and his coworkers.[2] Both consider silica glasses as continuous networks within which are wide, approximately periodic modulations in density, in stresses, and in the degree of structural regularity.

The proposed model is not inconsistent with known data on such properties of silica glass as density; differential diffusion of gases; interatomic distances derived from X-ray, electron, and neutron diffraction; low tensile strength; anomalous thermal and pressure effects on volume; and internal friction effects at low temperatures. Evidence in support of the concept is given by analyses of property-composition curves for solubility, chemical attack, volatilization, molar volume, and electrical resistance; and from differential diffraction studies of alkali silicate binary glasses.[3]

Present theories of glass structure view the atomic arrangement and interatomic distances of nearest neighbors in a glass and in its most closely related crystal as being similar. However, in glass, the many slight irregularities, cumulated over relatively long distances (on an atomic scale), are believed to introduce a randomness that masks the periodicity characteristic of crystals.

Under the vitron concept, glasses and crystals may be expected to differ more fundamentally because of the difference in their structural symmetries. Theoretically, growth in crystals can proceed indefinitely without stress. On the other hand, the vitron—because of its fivefold noncrystal symmetry—is automatically limited in growth by ever-increasing distortional stresses.

The vitron concept and related ideas on glass structure arose from extensive observations concerning the reversible volume changes in silica glass produced by annealings at different temperatures.[4] According to the vitron concept, these volume changes are caused by a temperature-sensitivity of the bond angles. This is in contrast to theories that attribute the changes to a stretching, or breaking and reforming, of the bonds.

According to the vitron concept, the density of silica substance should range from a low at very high temperatures in the melt, to a maximum density at absolute zero. On this basis, approximate limits for the density are 2.0, computed for undistorted elements of vitrons at 2,000° C, and 3.9 at absolute zero for closest rhombohedral packing of oxygen spheres appropriately impregnated with silicon atoms.

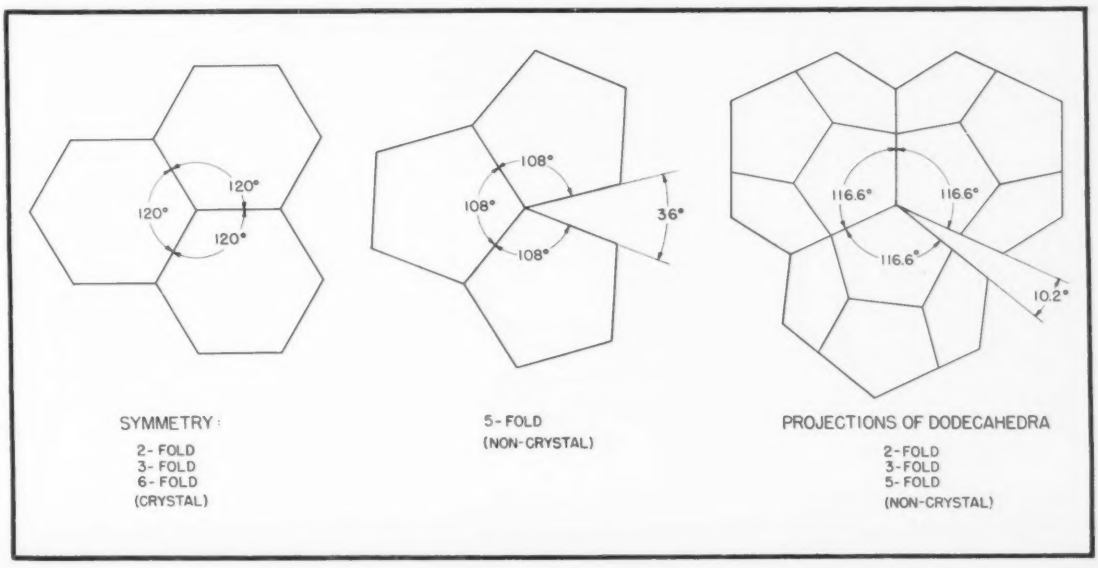
[1] *For further technical details, see* Noncrystal ionic model for silica glass, *by L. W. Tilton, J. Research NBS* **59**, *139 (1957) RP2782.*

[2] X-ray diffraction and the structure of vitreous solids, *by J. T. Randall, H. P. Rooksby, and B. S. Cooper, Z. Krist.* **75**, *196 (1930); and* The diffraction of X-rays by vitreous solids and its bearing on their constitution, *Nature* **125**, *458 (1930).*

[3] Role of vitrons in alkali silicate binary glasses, *by L. W. Tilton, J. Research NBS* **60**, *351 (1958) RP2854.*

[4] Structural rearrangements in silicate glasses during annealing, *by L. W. Tilton, Trans. Soc. of Glass Technology* **60**, *338 (1956).*

Diagrams of crystal (left) and noncrystal (center) clusters. Regular pentagonal dodecahedra fail to fill space completely in the same way that pentagonal tiles fail to cover a floor. However, by radial compression, neighboring dodecahedra (right) can be distorted so that a limited degree of growth in space is possible.



APPARATUS FACILITATES LENS TESTING

AN APPARATUS devised by F. E. Washer of the optical instruments laboratory measures spherical and chromatic aberrations in lenses with a high degree of accuracy. The equipment is proving very useful for the rapid testing of high-precision lenses such as those used in airplane cameras and in telescopes. With the aid of an optical T-bench equipped with nodal slides, a visual testing method is made possible. Outstanding features of the method are its simplicity, reliability, and versatility.[1]

By longitudinal spherical aberration is meant the variation in focal length for different annular zones of a lens. In other words, the focus for each zone occurs at a different place along the lens' optical axis. In order that corrections may be made for the resulting out-of-focus effects, accurate data must be obtained on the focal lengths of the various annular zones. These data are also important in lens design because they yield valuable information on expected performance and show the direction to be taken in improving the design.

When a light source is placed at the back focus of an annular zone of a lens with a longitudinal spherical aberration, the light from that zone emerges from the front of the lens at an angle to the lens axis. By isolating small areas along the lens diameter, it is possible to measure this angular deviation, ϵ, for each zone. From these measurements the change in focus from zone to zone can be readily determined by the approximate formula

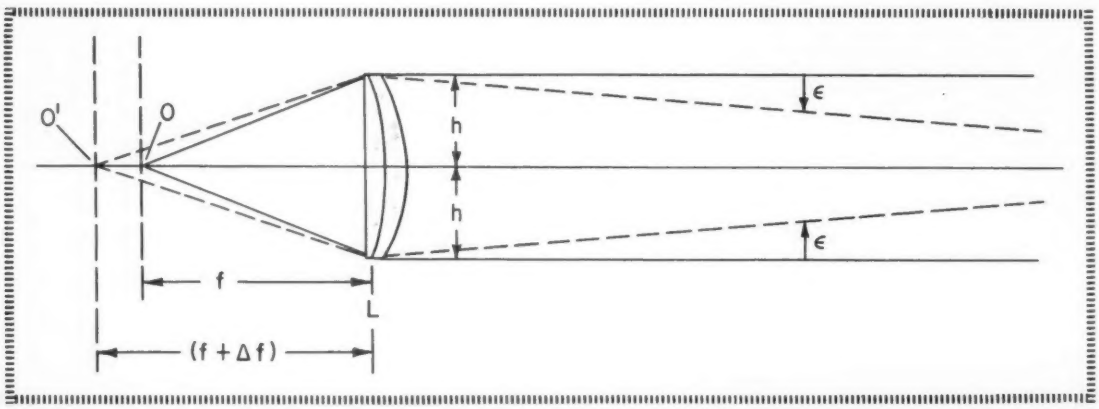
$$\Delta f = \frac{\epsilon}{h} f^2,$$

where Δf is the variation of focus or longitudinal spherical aberration; ϵ is the measured angular deviation; h is the zone height (distance from lens axis); and f is the equivalent focal length of the lens.

The testing apparatus consists of two optical benches mounted on a strong metal table at right angles to each other in the form of a T. The cross bench carries a nodal slide with the viewing telescope, and a movable slide on which a pentaprism is mounted. The perpendicular bench carries a nodal slide that supports the

Observer measures longitudinal spherical aberration in lenses with recently developed equipment. *Left to right:* A telescope on a nodal slide, and a pentaprism on a movable slide are mounted on the cross bench; on the perpendicular bench are mounted the lens on a nodal slide, and the reticle and light source on a movable slide.

Drawing demonstrates the principle of the instrument developed to measure longitudinal spherical aberration in lenses. When a light source is placed at the focus *O* of the lens *L*, the light incident on the back surface of the lens emerges parallel to the lens axis. When *O* is moved by amount Δf to *O'*, the beam converges and a ray located at zone height *h* is deviated through the angle ϵ.



lens under test, and a movable slide to which the reticle and light source are attached. The pentaprism is used to direct the light emerging from the lens under test to the telescope. The size of the telescope's aperture is limited as required by diaphragms with openings of from 1 to 10 mm.

When the slide with the pentaprism is moved along the cross bench, each annular zone along the lens diameter is isolated, and the angle ϵ, separating successive beams from the central beam, can be measured by the micrometers mounted on the telescope. Values for the longitudinal spherical aberration Δf can then be computed for each zone height h. By plotting the values of Δf as abscissae against h as ordinate, the typical spherical aberration curve is formed.

Information is obtained on longitudinal chromatic aberration by first determining the longitudinal spherical aberration for a series of color filters. This is done by placing each filter in the light path between the light source and the illuminated reticle, and then by plotting the Δf versus h curves from the data derived for each color. The separation of these curves along the axis of abscissae is a measure of the longitudinal chromatic aberration.

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[1] *For further technical details, see* Optical T-bench method of measuring longitudinal spherical aberration, *by F. E. Washer, J. Research NBS* **61**, *31 (1958) RP2880.*

New Zinc Spelter Standard for Spectrographic and Chemical Analysis

A NEW STANDARD sample of zinc spelter is now available from the Bureau. Its composition is modified by the addition of 0.5 percent aluminum, necessary for minimizing the introduction of iron during the melting process. Analyzed for 16 elements and certified for 8 of these, the spelter standard is intended for checking and calibrating spectrochemical and chemical methods used in analyzing high-purity zinc, spelter, and wrought zinc alloys. It should thus be of value to the producers of these alloys for controlling the quality of their products.

By providing lower concentrations of impurity elements, the spelter standard supplements the zinc-base, die-casting spectrographic standards issued in 1956. Both these and the new standard were developed as the result of a cooperative research program between the National Bureau of Standards and General Motors Corporation. The Chicago branch of the National Lead Company prepared the samples by a special continuous casting process. The homogeneity of the samples was investigated both at the National Bureau of Standards and at General Motors Corporation.

Spelter is the commercial term generally used to represent zinc below 99.8-percent purity. The composition of the new spelter standard is certified for aluminum, iron, indium, copper, cadmium, manganese, chromium, and tin. It has also been analyzed for gallium, silicon, lead, magnesium, calcium, nickel, silver, and germanium. However, the latter group of elements was not certified because of a limited amount of analytical data. These elements may be certified at a later date.

The spelter standard is issued as a bar segment, $1\frac{3}{4}$ in. square and $\frac{3}{4}$ in. thick. The certified portion is that portion included between $\frac{3}{16}$ in. and $\frac{11}{16}$ in. from each side of the square section of the sample.

The sample may serve as a self electrode in opposition to a high-purity electrode in the point-to-plane technique of spectrochemical analysis. In many cases the low concentrations of the impurity elements will necessitate employing a method in which drillings or chips are taken from the homogeneous area and dissolved. The resulting solution or derived powder can then be used in the analytical procedure.

Chemical analyses on millings representing the certified portion of the sample were made by the National Bureau of Standards, General Motors Corporation (Research Division), Apex Smelting Company, and Metal and Thermit Corporation. Spectrochemical analyses were made by the Bureau.

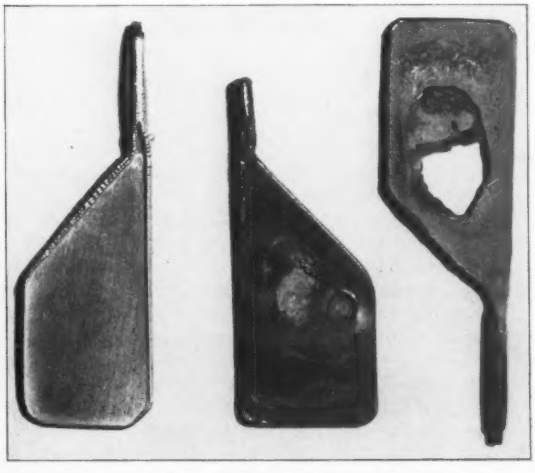
The zinc spelter sample may be obtained from the Standard Sample Clerk, National Bureau of Standards, Washington 25, D. C. The fee is $10.00 per sample. A provisional certificate supplied with the standard lists the average values of the analyses reported by the cooperating laboratories.

Composition of NBS Spectographic Sample of Zinc Spelter (modified) No. 631

Elements certified	Concentration	Elements not certified	Concentration
	%		%
Al	0.50	Ga	0.00$_2$
Fe	.005	Si	<.002
In	.002$_3$	Pb	<.001
Cu	.001$_3$	Mg	<.001
Cd	.0002	Ca	<.001
Mn	.0001$_8$	Ni	<.0005
Cr	.0001	Ag	<.0005
Sn	.0001	Ge	.000$_2$

High-Temperature Coating for Molybdenum

TO PROTECT MOLYBDENUM against high-temperature oxidation, the National Bureau of Standards, in research performed for the Navy Bureau of Aeronautics, has investigated a composite electrodeposited coating of nickel over chromium.[1] Although molybdenum has greater structural strength at high temperatures than steel, it has not, thus far, been used under such conditions because of its ease of oxidation. However, with the protective coating studied by D. E. Couch and associates, oxidation of molybdenum is prevented for over 1,000 hr at 980° C, and for over 300 hr at 1,100° C. The two-layer coating is therefore considered a promising material for use on turbine blades and similar high-temperature components.



Typical test panels of molybdenum coated with the composite chromium-nickel coating. Panel at left has not been heated. The other two have been heated for 300 hr at 1,100° C. Difference between these last two shows the variation in samples prepared under identical conditions.

A high-temperature coating for molybdenum must have a number of special properties. The coating must, of course, be oxidation-resistant, but it is equally essential that it be nonporous and ductile. Even minute imperfections can allow the molybdenum beneath the coating to oxidize and to disappear completely within a few hours. Studies of the chromium-nickel coating show that if properly applied, it satisfies these requirements.

The first step in the plating procedure is to etch the molybdenum with a 1:1 solution of concentrated sulfuric and phosphoric acids. A 1-mil chromium deposit is electroplated on the molybdenum at 85° C and 120 amp/dm^2. Then the newly plated surface is again etched, this time with a 1:1 hydrochloric acid, given a nickel strike, and plated with 7 mils of nickel. For this purpose, nickel deposited from a Watts type bath at 2 to 5 amp/dm^2 is superior to that deposited from an all-chloride bath.

Durability Studies

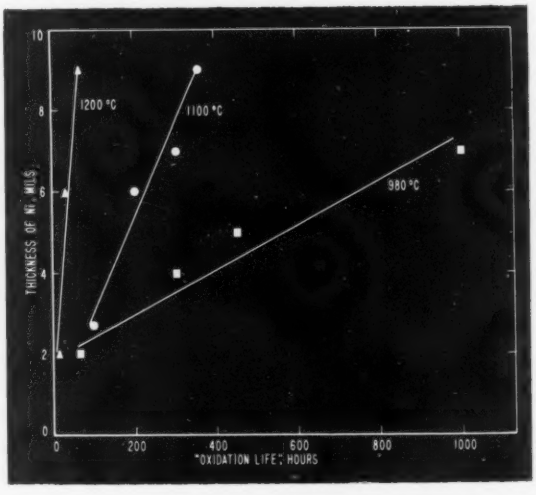
Several types of durability experiments were conducted with the coated samples. To test the adhesion of the coating to the molybdenum, the completed specimens were bent until fractured. The break produced was usually within the molybdenum itself and not between the electrodeposited layers—showing excellent adhesion of the plating. To a large extent, the soundness of the deposit determines the effectiveness of the protection.

Specimens with the composite coating were exposed to air at 1,100° C until the coatings were perforated or until a white smoke of molybdic oxide appeared. At this temperature, the coating withstood oxidation for an average of 300 hr; but at 1,200° C oxidation was greatly accelerated. Preheating of the samples in an inert atmosphere decreased the oxidation life of the coatings.

Types of Defects

In metallurgical examinations of a series of the coated specimens which had been subjected to different periods of air oxidation at 1,100° C, three underlying causes of failure were noted: Subsurface oxidation; grain-boundary oxidation; and edge separation.

Effect of temperature and nickel thickness on the length of time molybdenum protected by the chromium-nickel coating can withstand oxidation. Oxidation is prevented for over 1,000 hr at 980° C and for over 300 hr at 1,100° C.



Micrographs of electrodeposited nickel-chromium-nickel in cross section. 'A': initial sample with coating. 'B' and 'C': extent of oxidation at 1,100° C after 70 and 300 hr, respectively. (Approximately × 60.)

The subsurface oxide is due to reaction with atmospheric oxygen and not with oxygen trapped in the coating. This explanation is plausible because the oxide was not observed in samples heated in a helium atmosphere. Apparently the subsurface oxide layer is caused by diffusion of the atmospheric oxygen which passes through the nickel coating and reacts with the nickel-chromium alloy underneath. Further support of this explanation is the fact that the low-chromium alloy is more easily oxidized than is pure nickel. The subsurface oxide forms through much thicker layers of nickel over a curved surface than over a flat surface.

The boundaries of the metal crystals are more vulnerable to oxygen attack. Hence, as its name implies, grain-boundary oxidation directly follows the boundary of the grains.

Edge separation occurs within the chromium-nickel diffusion layer when a sample is alternately heated and cooled several times. This type of defect, which is being further investigated, actually produces a gap within the layers.

To observe more closely the effect of molybdenum diffusing through the coating, a study was also made of interdiffusion of the three metals—molybdenum, chromium, and nickel. For this experiment, a bar of molybdenum was plated with 2 mils of chromium and 14 mils of nickel, and then heated in hydrogen. After 600 hr, 1 to 2 percent of the molybdenum had diffused to the surface. Although this metal could be detected through 10 mils of nickel, no structural changes were noted. Apparently small amounts of the molybdenum which have diffused into the surface do not appreciably affect the grain structure of the chromium-nickel alloy coating.

In further investigations of the three types of defects, electroformed nickel instead of molybdenum was coated with chromium and nickel and then oxidized. Upon examination, the same three formations—subsurface oxide, grain oxidation, and edge separation—which had occurred with the coated molybdenum—were noted. Thus, molybdenum itself is not directly involved in these major sources of failure.

[1] *For further technical information, see* Protection of molybdenum from oxidation at elevated temperatures, *D. E. Couch, H. Shapiro, J. Taylor, and A. Brenner, J. Electrochem. Soc.* **105**, *450 (1958).*

Distribution of Certain Longer-Lived Radioisotope Standards

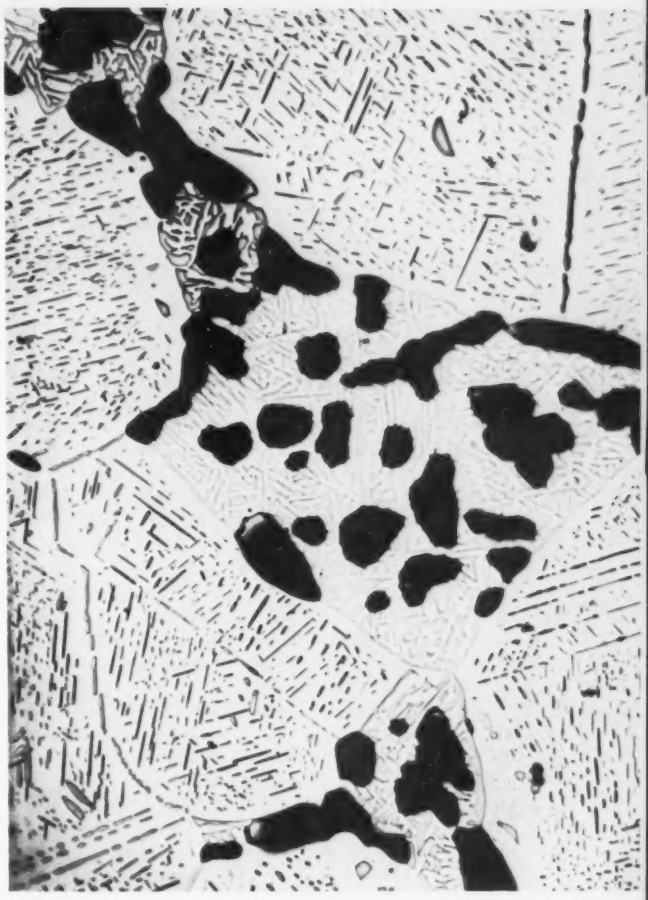
EFFECTIVE September 18, 1958, the Bureau has discontinued the distribution of the following radioactivity standard samples of longer-lived radioisotopes which are now commercially available:

NBS Standard Sample 4910, Radium D+Radium E
NBS Standard Sample 4911, Radium D+Radium E
NBS Standard Sample 4912, Radium D+Radium E
NBS Standard Sample 4913, Cobalt-60
NBS Standard Sample 4914, Cobalt-60
NBS Standard Sample 4915, Cobalt-60
NBS Standard Sample 4919, Strontium-90/Yttrium-90
NBS Standard Sample 4920, Thallium-204
NBS Standard Sample 4928, Sulfur-35
NBS Standard Sample 4931, Cesium-137/Barium-137
NBS Standard Sample 4934, Tantalum-182
NBS Standard Sample 4936, Iron-59

Standardized samples of these nuclides may be obtained from the Nuclear-Chicago Corporation, 223 West Erie Street, Chicago 10, Ill. The standards to be issued by this firm are derived from comparisons made with the national standards maintained by the Bureau. The firm, however, has accepted full responsibility for the standardization of the samples that it distributes.

Discontinuance of this activity permits the Bureau to devote more of its resources toward meeting the demands of science and industry for new and more accurate standards. The Bureau's action also conforms with the Federal Government's general policy of withdrawing from activities that can be carried on by private business. The Bureau will, however, continue to maintain the primary disintegration-rate standards of these nuclides. Previously, in May 1957, the Bureau discontinued distribution of five short-lived radioisotope standards. These nuclides, also available from Nuclear-Chicago, are Phosphorus–32 (NBS Sample No. 4916), Iodine–131 (No. 4917), Gold–198 (No. 4918), Sodium–24 (No. 4923), and Potassium–42 (No. 4933).

UNUSUAL MICROSTRUCTURE OF CHROMIUM—NICKEL—MOLYBDENUM ALLOY——→



THIS PHOTOGRAPH, entered by C. J. Bechtoldt and P. D. Sarmiento of the Bureau's mechanical metallurgy laboratory, received third prize in the "photomicrographs—super alloys" class at the American Society for Testing Materials 1958 Photographic Exhibit. Photograph was taken during a study of transformations occurring in a 47.5 Cr–47.5 Ni–5.0 Mo alloy. The sigma phase (dark, stained areas) was found to form only in grains that were alpha phase at higher temperatures.

GAS EVOLVES FROM PROPAGATING FATIGUE CRACK UNDER TRANSPARENT TAPE

Photo at bottom left shows specimen with tape removed

THIS ENTRY by Miss Ruth E. Dowden of the Bureau's mechanical metallurgy laboratory received second prize in the "photomicrographs—methods" class at the American Society for Testing Materials 1958 Photographic Exhibit. Photograph was taken during a torsion fatigue test on an aluminum alloy. Transparent tape had been applied to the surface of a flat specimen in which a minute fatigue crack had been induced. As additional cyclic stress was applied, an increasing volume of gas was produced under the tape.

AN ENTRY entitled "Streak photo of 3,500 cm/sec flame front interacting with salt-coated screen", submitted by Thomas G. Lee of the fire resistance laboratory, received third prize in the "general color" class at the Exhibit.

See other award-winning photograph at top of page 236.

Uranium Isotopic Standards

Now Available

Under AEC–NBS Cooperative Program

THE BUREAU, in cooperation with the Atomic Energy Commission, has prepared the first of a series of uranium isoptopic standards for use by educational and research institutions and industry in the United States and abroad.

Eight standard uranium isotopic samples became available from the Bureau on October 1, 1958. Seven additional uranium standards are in preparation to complete a series of fifteen.

Standards for other atomic energy materials such as plutonium and thorium will be made available under a continuing program intended to provide materials of known certified composition which will be universally acceptable as analytical standards.

Development of standard materials of accurately known composition on which to base measurements with a high degree of precision and accuracy has long been a major interest to users of atomic energy materials. Over a period of years, various Atomic Energy Commission laboratories and contractors have studied and developed standard materials for their own use. The considerable expansion in recent years in the uses of atomic energy has underlined the need for standard materials which will be widely accepted. To meet this demand, the Commission, with the aid of committees drawn from industry, has cooperated with the National Bureau of Standards to establish a continuing program to provide the needed standard materials.

The uranium isotopic standards become a part of the Bureau's standard samples program involving some 600 certified standard materials which are available to science and industry.

The eight standards which became available from the Bureau on October 1 represent the first results of the AEC–NBS cooperative program. These will be at levels (weight percent U^{235}) of 1.5, 2, 3, 5, 20, 85, 90, and 93. The seven additional standards to be made available later will be at levels of 0.5, 1, 10, 15, 35, 75, and 80. A natural uranium chemical standard rounds out the uranium series.

Each isotopic standard issue unit consists of a quantity of uranium oxide (U_3O_8) equivalent to 1 g of uranium. The chemical standard issue unit consits of 25 g of uranium oxide and sells for $5.00. Charges for the isotopic standards vary from $20.50 to $37.50 per issue unit depending on the enrichment level.

Initially, provisional certification values will be provided with the standards. Final certification will follow when evaluation work now underway is completed. The U–234, U–236, and U–238 contents of the standards will also be shown on the certificate of analysis.

Standards supplied by the Bureau are available only to the Commission's contractors and licensees, and to foreign governments having appropriate agreements for cooperation with the United States. Licensees are authorized to receive only those standards of the enrichment for which they are licensed. Licenses may be obtained through the Division of Licensing and Regulation, U. S. Atomic Energy Commission, Washington 25, D. C.

Order forms for domestic use (AEC contractors and licensees) may be obtained from the National Bureau of Standards, Washington 25, D. C. Orders from foreign sources should be submitted to the Division of International Affairs, U. S. Atomic Energy Commission, Washington 25, D. C.

Price list of uranium isotopic standards

Standards certified for uranium isotope abundance		
Issue unit: uranium oxide, U_3O_8, equivalent to 1 g of uranium		
Standard No.	Nominal composition	Price
	% U^{235}	
U005	0.5	$20.50
U010	1.0	20.50
U015	1.5	20.50
U020	2.0	21.00
U030	3.0	21.00
U050	5.0	21.00
U100	10.0	22.00
U150	15.0	23.00
U200	20.0	23.50
U350	35.0	26.50
U750	75.0	33.50
U800	80.0	34.00
U850	85.0	35.00
U900	90.0	36.00
U930	93.0	37.50
Standard certified for uranium content		
Unit of issue: 25 g, U_3O_8 natural uranium		
950		5.00

EVALUATION OF LEATHER IMPREGNANTS

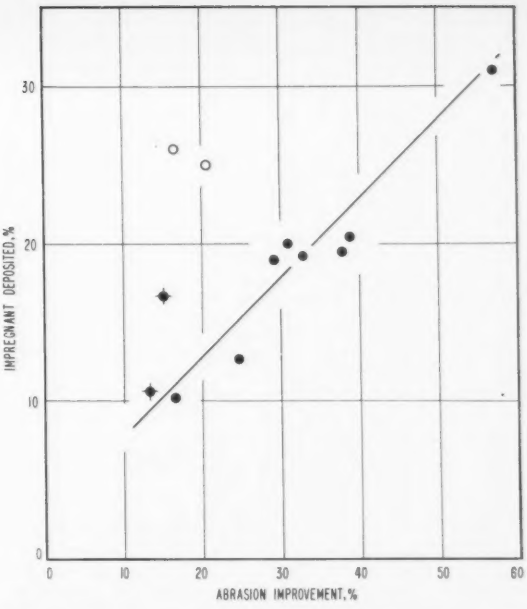
WHEN CHOOSING an impregnant to improve the properties of leather, first consideration should be given to the molecular weight of the elastomer component, according to a National Bureau of Standards study for the Navy Bureau of Supplies and Accounts. It is the elastomer blended in the impregnating solution that improves leather's wear and water resistance. The study shows, however, that the degree of improvement achieved depends on the amount of impregnant deposited throughout the leather's thickness; and that only elastomers with a molecular weight of less than 10,000 can effectively penetrate the leather. Best results are obtained with impregnants incorporating elastomers such as polybutene, polyisobutylene, or butyl rubber,[1] in combination with resins.

At the request of the Army Quartermaster General, a research program to increase the wear of shoe leather was started at the Bureau several years ago. Early investigations disclosed that polymeric substances can be deposited in the woven matrix of leather's collagen fibers, and that proper impregnation with these substances prolongs leather's serviceability. Impregnating techniques devised at the Bureau in 1955 are now employed by industry to produce leathers having various degrees of waterproofness, flexibility, and durability.[2]

At the time these techniques were developed, elastomers with molecular weights of from 50,000 to 100,000 were generally used for impregnants. But since then elastomers with low molecular weights have become increasingly popular because they provide greater ease of handling. To compare the properties imparted to leather by the variety of materials now available, B. H. Fouquet and J. R. Kanagy of the leather laboratory undertook the present work.

Dried vegetable-tanned crust leather was used in the experiments to assure maximum absorption of the impregnant. Previous experiments had shown that impregnation with elastomeric materials affected the dimensional stability of sole leather during service. To eliminate this defect, the elastomers were blended with a semihard hydrocarbon resin or with a polymerized resin in a 2 to 3 proportion. A low-viscosity solution was made by mixing together equal parts of the blended substance and a petroleum solvent. After the leather was immersed in this solution for 3 hr, it was drained and then dried in a forced-draft oven at 40°C to remove the solvent.

Actual wear tests on shoes worn by Navy personnel showed that wear was improved by 50 percent. Laboratory tests indicated that water resistance and abrasive resistance are directly proportional to the amount of impregnant deposited in the leather. The quantities



Effect of amount of impregnant deposited, on the improvement in leather's abrasive resistance. (●—low-molecular-weight elastomers; ◆—high-molecular-weight elastomers; O—resin and oil blend.)

Setting up the apparatus used to extract impregnant from leather specimens.

deposited were calculated on a dry basis from the weight of the leather sample before and after impregnation. Depositions of approximately 20 percent of the low-molecular-weight substances can increase abrasive resistance 30 to 40 percent and reduce water absorption 35 percent.

As part of the experiment, the specimens were split into three layers and the impregnant was extracted from each layer with chloroform. It was found that blends containing low-molecular-weight elastomers deposited more than twice as much impregnant in the corium (middle) layer as did blends containing high-molecular-weight elastomers. This variation is attributed to the unequal pore-size distribution throughout the leather matrix, which ranges from the largest size pores in the grain (outer) layer, to the smallest size pores in the corium, to intermediate size pores in the flesh (outer) layer. Therefore, an elastomer with relatively large molecules does not readily penetrate the more compact fibers of corium but tends to remain in the larger pores of the outer layers.

[1] *For further technical details, see* Impregnation of sole leather with polymers, *by Bernard H. Fouquet and Joseph R. Kanagy, J. Am. Leather Chemists' Assoc.* **53**, *336, (1958).*

[2] A pilot plant study of the process for treating heavy leather with polyisobutylene and other polymers, *by René Oehler, John H. Davis, and Raymond Kinmonth, J. Am. Leather Chemists' Assoc.* **50**, *16 (1955)*; Improved techniques for impregnating leather, *NBS Tech. News Bul.* **39**, *96 (1955)*.

Graduate School Celebrates 50th Anniversary

ON OCTOBER 16, the National Bureau of Standards Graduate School celebrated its golden anniversary, in a program which featured one of its distinguished alumni, Hugh L. Dryden, formerly Associate Director of the Bureau, and currently Deputy Administrator, National Aeronautics and Space Administration. Dr. Dryden spoke on "The Space Frontier".

Other speakers were Allen V. Astin, NBS Director, who discussed the entire educational program at the Bureau, and James I. Hoffman, Chief of the Metallurgy Division, who described the early years of the School.

James I. Hoffman (right), NBS Educational Committee Chairman, is shown with his two predecessors (left to right), Wallace R. Brode, formerly Associate Director of the Bureau, now Science Advisor to the Department of State, and Louis B. Tuckerman. The first chairman, Clarence W. Kanolt, was unable to attend the celebration.

In addition to the Graduate School, the Bureau's educational program includes Postdoctoral Resident Research Associateships, sponsored by the National Academy of Sciences—National Research Council, seminars, lectures, colloquia, and weekly scientific staff meetings. This broad educational program provides an opportunity for the scientific staff of the Bureau and other Government agencies to further their education and increase their opportunities to take on added responsibilities.

Through the years, more than 13,000 people have taken courses at the Graduate School. Many major universities accept, for credit, courses taken at the school and thesis work done in the Bureau's laboratories. On the basis of this credit, almost three hundred advanced degrees have been earned by students of the school. At present, courses at the school are given in cooperation with American University, the University of Maryland, and George Washington University.

The Bureau's Graduate School, the first of its kind in Government, inaugurated a new concept in Government and education—a graduate educational facility, operated in conjunction with a professional scientific laboratory. It has served as a model for several such institutions in other agencies, including the Agriculture Department and the Department of the Navy. In 1946, a series of in-hours courses was initiated and this pioneering program has since been adopted by other similar schools.

Two of the first four courses offered in 1908 (Differential Equations and Thermodynamics) are also on the curriculum for this year. The range of courses is wide, reflecting the Bureau's interest and work in almost every area of the physical sciences. The Graduate School has been extended to the Boulder, Colo., Laboratories, in cooperation with the University of Colorado.

FABRIC SHRINKAGE TEST EVALUATED

Results of an Interlaboratory Study

THE NATIONAL STANDARDIZING BODIES of 15 countries recently completed an interlaboratory study of a test method for fabric shrinkage in washing. Purpose of the study was to obtain a basis for agreement on a standard method that would facilitate international trade in textiles. The study was planned and coordinated by staff members of the National Bureau of Standards under the auspices of the American Standards Association. Data derived from the intercomparison showed a striking similarity in the test results of the various laboratories, and also indicated that the test method is easily reproducible. It has, therefore, been submitted to the International Organization for Standardization (ISO) for review and issuance as a formal ISO recommendation for international use.

Cooperating in the effort were 20 laboratories in Belgium, Canada, Czechoslovakia, Denmark, France, Germany, Japan, Netherlands, Norway, Poland, Sweden, Switzerland, Union of South Africa, the United Kingdom, and the United States. Ten of the fabrics were supplied by mills in this country and six by organizations in England. The fabrics were cut into specimens, labeled, and shipped to the participating laboratories by the American Association of Textile Chemists and Colorists Laboratories, Lowell, Mass., and the British Launderers' Research Association Laboratories in London.

The method studied was substantially a standard test that has been followed for several years in the United States to evaluate the effect of high-temperature laundering on dimensional changes in woven fabrics.[1] The test machine and soap solution recommended are similar to those used in commercial laundering. The 16 textile specimens were selected because of their known behavior when subjected to repeated tests or launderings.

With the exception of the duration of the test, all requirements of the test method had been agreed upon before the study was undertaken. The American Standards Association had suggested a 60-min test because it is less costly to perform. However, as some of the participants felt that longer tests would be necessary in order to obtain values for the ultimate fabric shrinkage, three different testing periods—60, 80, and 100 min—were scheduled.

Analysis of the test results showed that repeated applications of the 60-min test gave reliable data on progressive shrinkage. The results obtained in the laboratory test were in close agreement with the results of repeated commercial laundering. It was found in some cases that less shrinkage occurred in the longer time tests than in the 60-min test (see table). The short test period was, therefore, specified in the method submitted for international adoption.

Comparison of results of the 60-, 80-, and 100-minute tests, applied once; averages for all laboratories †

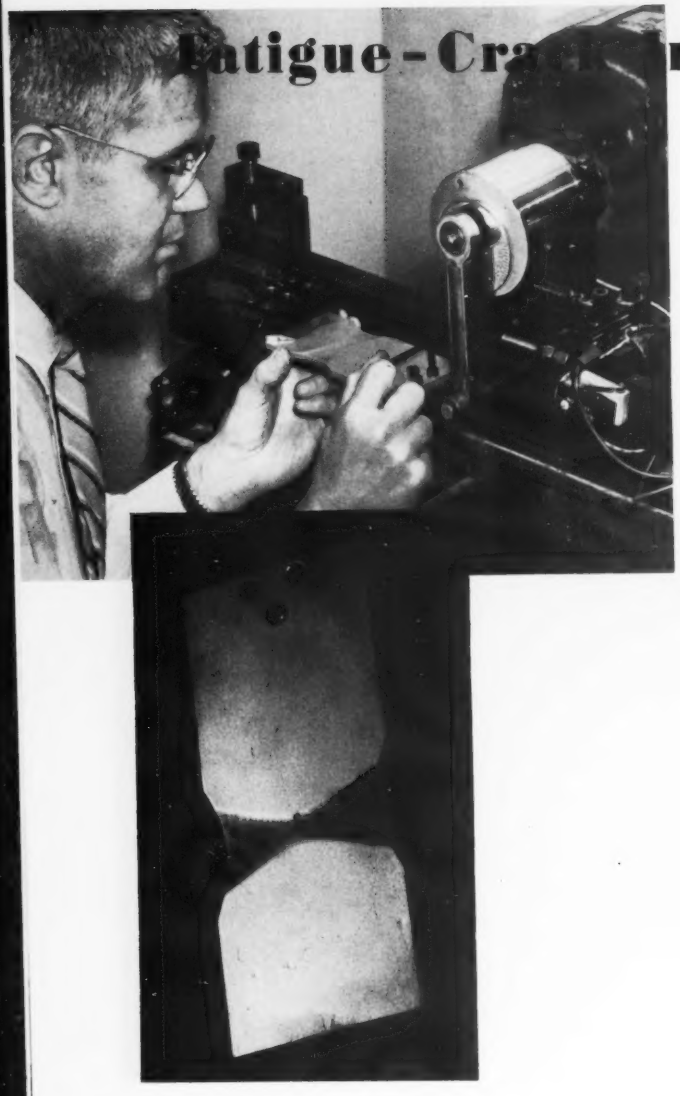
Fabric	Direction	Average shrinkage or stretch (+) in percent			Difference in results between	
		60-min test	80-min test	100-min test	60- and 80-min test	60- and 100-min test
Broadcloth shirting	U—W	2.9	3.0	2.9	0.1	0.0
	U—F	+0.7	+0.6	+0.6	.1*	.1*
	S—W	+.6	+.6	+.6	.0	.0
	S—F	.4	.3	.4	.1	.1
Chambray	U—W	7.6	7.2	7.7	.4	.1
	U—F	6.7	6.8	7.0	.1	.3
	S—W	0.5	0.5	0.6	.0	.1
	S—F	1.2	1.3	1.5	.1	.3
Denim	U—W	11.4	11.5	11.7	.1	.3
	U—F	5.0	5.1	5.4	.1	.4
	S—W	0.0	0.3	0.0	.3	.0
	S—F	.7	.7	1.0	.0	.3
Drill, mineral khaki	U—W	8.1	8.6	8.1	.5	.0
	U—F	0.0	+0.2	+0.1	.2	.1
	S—W	+.6	+.4	.2	.2*	.4*
	S—F	+.4	+.3	+.3	.1*	.1*
Drill, sulfur blue	U—W	10.2	10.6	10.9	.4*	.7
	U—F	+1.8	+1.5	+1.3	.3*	.5*
	S—W	1.6	1.8	2.0	.2	.4
	S—F	2.4	2.4	2.5	.0	.1
Drill, white	U—W	6.8	7.0	7.2	.2	.4
	U—F	+0.4	+0.3	+0.4	.1*	.0
	S—W	.7	1.0	1.0	.3	.3
	S—F	.6	0.5	0.6	.1*	.0
Gabardine, rayon	Reg—W	14.4	14.8	15.7	.4	.3
	Reg—F	1.7	1.6	1.8	.1*	.1
	Stab.—W	2.5	2.8	3.2	.3	.7
	Stab.—F	0.5	0.5	0.5	.0	.0
Printcloth	U—W	5.6	5.7	6.0	.1	.4
	U—F	7.7	8.0	8.0	.3	.3
	Stab.—W	0.5	0.6	0.6	.1	.1
	Stab.—F	.8	.8	1.0	.0	.2

U—unshrunk
S—shrunk
Reg—regular finish
Stab.—stabilized finish
W—warp direction
F—filling direction
*—less change in dimension in 80-min or 100-min test than in 60-min test
+—increase in dimension
†The number of laboratories whose results are included in each average varied from 9 to 13

The standard deviation expressing variability between duplicate fabric specimens tested at different times in the same laboratory was 0.56 in percent shrinkage, and the standard deviation between duplicate specimens tested in different laboratories was 0.85 in percent shrinkage. An increase in the fabric load from 0.5 lb to 3 lb per cubic foot in the testing machine's cage space had very little effect upon average dimensional changes.

[1] *For further technical details, see* Test for dimensional changes in woven fabrics in high-temperature laundering, *by William D. Appel, American Dyestuff Reporter* **47**, *213 (1958).*

Fatigue-Crack Initiation in Metals



Mounting a specimen on a plate bending machine used to investigate the fatigue strength of metals. The left end of the specimen is clamped in a vise and the right end is oscillated by a motor-driven eccentric and connecting rod. Because of the specimen's saddle-shaped reduced section, the stress at the center is higher than that at the edge. (See insert.)

THE EFFECT of geometrical factors on fatigue-crack initiation in metals has been investigated by the Bureau for the National Advisory Committee for Aeronautics. It has been commonly observed in bending tests that fatigue cracks start at the edge of a plate or sheet specimen. This naturally led to the conclusion that resistance to fatigue-crack initiation is lower at the edges than on a flat surface. However, in recent Bureau experiments a type of specimen was used that permitted a direct comparison of the fatigue strengths both at the edges and on a nearly flat surface. The results indicate that the preponderance of edge cracks previously observed in conventional specimens is caused by the stress pattern rather than by lower fatigue strength at the edges.[1]

The initiation of fatigue cracking is usually the first sign of metal failure, and is thus of considerable interest to metallurgists and design engineers. Several investigators have attempted to evaluate the tendency of cracks to start at the edges by comparing data obtained from testing specimens of various shapes.[2] Their results, however, were not always consistent. Among factors thought to influence the results were the lack of restraint against slipping in the material at the edge, and the stress present in the specimen's surfaces. In order to obtain quantitative information on these factors, the present investigation was undertaken.

The specimens used in the bending tests were especially designed by J. A. Bennett and J. G. Weinberg of the mechanical metallurgy laboratory. Made of 1/4-in.-thick plate, they were 7 in. long, and from 2 to 3 in. wide. A reduced section toward the middle of the specimen was formed by 4 cuts. The two broad surfaces were each milled into the shape of a saddle; and rounded notches were cut into the adjacent edges, varying in depth according to the desired width. The saddle-shaped surfaces were designed to provide maximum thickness at the center of the reduced section.

Tests were conducted on a plate bending machine. One end of the specimen was clamped in a vise and the other end was oscillated by a motor-driven eccentric and connecting rod. Because of the shape of the reduced section, the axial stress in the center was greater than at the edge. By varying the contour of the saddle shape and the width of the specimen at the reduced section, it was possible to obtain any desired value for edge-to-center stress ratio. Then by observing crack-origin location, the relative probability of edge and non-edge cracks could be determined as a function of edge-to-center stress ratio.

Results obtained with 5052–H34 aluminum alloy specimens show that the reduction of fatigue strength at the edge decreases as the specimen width decreases, and that no reduction might be expected for a specimen of zero width. From this it appears that the probability of fatigue cracking at the edge is not caused by lack of restraint but by the strengthening effect of biaxial stress on the surface away from the edge.

By changing the radius and included angle at the edges of the specimen's reduced section, the techniques used in these tests can be adapted to investigate the influence of other geometrical factors on metal fatigue. As the results depend on the comparative fatigue strength of different portions of individual specimens, many possible sources of error are eliminated.

[1] *For further technical details, see* A toric bending specimen for investigation of geometrical factors in fatique, *by J. A. Bennett and J. G. Weinberg, ASTM Bul. (in press).*

[2] Influence of type of machine, range of speed, and specimen shape on fatigue test data, *by P. K. Roos, D. C. Lemmon, and J. T. Ransom, ASTM Bul. No. 158, p. 63 (May 1949);* The influence of shape of cross section on the flexural fatigue strength of steel, *by J. T. Dolan, J. H. McClow, and W. J. Craig, Trans. ASME,* **72**, *469 (1950);* Shape as a factor in flexural fatigue strength, *by H. T. Corton and T. J. Dolan, U. of Ill., Theoretical & Applied Mechanics Report, No. 84 (May 1955);* and The effect of size, shape, and grain size on the fatigue strength of medium carbon steel, *by C. Massonnet, Proc. ASTM,* **56**, *954 (1956).*

Hoffman Receives Fisher Award

DR. JAMES I. HOFFMAN, Chief of the Bureau's Metallurgy Division, has been named to receive the Fisher Award in Analytical Chemistry. Announcement of the award was made by C. F. Rassweiler, President of the American Chemical Society (ACS), at the Society's meeting in Chicago, September 8. The award, which consists of $1,000 and an etching, will be presented at the ACS spring meeting in Boston next year. The award is the highest recognition for work in analytical chemistry in the United States and Canada.

Dr. Hoffman joined the Bureau in 1919. He was appointed Chief of the Surface Chemistry Section in 1947 and then Assistant Chief of the Chemistry Division in 1952 before being named to his present position in 1956.

Born in Enterline, Pennsylvania, in 1893, Dr. Hoffman received his B. A. in chemistry from Franklin and Marshall College in 1918, his M. S. from George Washington in 1921, and his Ph. D. from American University in 1930. In 1943, Franklin and Marshall College conferred upon him the Sc. D. degree, *honoris causa.*

The author or co-author of 35 papers and three books in his field, Dr. Hoffman was awarded the Hillebrand Prize in 1946 for his work in developing a method for producing aluminum from low-grade clays. He has also received gold and silver medals from the Department of Commerce, and Alumni Awards from Franklin and Marshall College and American University.

Dr. Hoffman has been President and Councilor of the Chemical Society of Washington, and he is a member of the Washington Academy of Sciences, the American Society for Metals, Sigma Xi, Phi Beta Kappa, and Alpha Chi Sigma.

HIGH-ENERGY HIGH-INTENSITY ELECTRON ACCELERATOR

THE BUREAU has initiated a design study for a new high-energy, high-intensity electron accelerator. The accelerator is expected to have an energy in excess of 50 Mev and an electron-beam power of the order of 40 kw.

The design study by the Bureau's high-energy radiation laboratory will last approximately 1 year. In addition to the accelerator design and shielding problems, the study will examine the application of the accelerator to problems in such fields as measurement standards for high-intensity electron beams, research in nuclear and particle physics, free radical research, and radiation damage studies. The feasibility of storage rings or similar devices will be included in the investigation. Studies will be conducted with the help of consultants drawn from universities and industry and by subcontract work.

The accelerator design and auxiliary studies should result in a detailed specification for the accelerator by the spring of 1959. If funds for the accelerator and a laboratory building are provided, accelerator and building contracts will be awarded during that summer. The proposed building would also house the present 50-Mev betatron and 180-Mev synchrotron, laboratory and office facilities, and be located on the new Bureau site, a 550-acre tract of land near Gaithersburg, Md.

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Publications of the National Bureau of Standards

Periodicals

(Note New Prices)

Journal of Research of the National Bureau of Standards, Volume **61**, No. 5, November 1958 (RP2906 to RP2913 incl.) 60 cents. Annual subscription $5.00, $1.75 additional for foreign mailing.

Technical News Bulletin, Volume **42**, No. 11, November 1958. 15 cents. Annual subscription $1.50, 75 cents additional for foreign mailing.

Basic Radio Propagation Predictions for February 1959. Three months in advance. CRPL–D171. Issued November 1958. 10 cents. Annual subscription $1.00, 50 cents additional for foreign mailing.

Research Papers

Journal of Research, Volume ***61****, No. 5, November 1958. 60 cents.*

RP2906. On the diffraction and reflection of waves and pulses by wedges and corners. F. Oberhettinger.

RP2907. A liquid-helium cold cell for use with an X-ray diffractometer. Igor A. Black, Leonard H. Bolz, Frank P. Brooks, Floyd A. Mauer, and H. Steffen Peiser.

RP2908. The second spectrum of ruthenium (Ru II). Allen G. Shenstone and William F. Meggers.

RP2909. Self-ignition temperatures of materials from kinetic-reaction data. Daniel Gross and A. F. Robertson.

RP2910. Some studies of atmospheric transmittance on Mauna Loa. Ralph Stair and Russell G. Johnston.

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NBS Publications (*Continued*)

RP2911. Central notations for the revised ISCC–NBS color-name blocks. Kenneth L. Kelly.

RP2912. Viscosity of *n*-hexadecane. Robert C. Hardy.

RP2913. Revision of the phase equilibrium diagram of the binary system calcia-titania, showing the compound $Ca_4Ti_3O_{10}$. Robert S. Roth.

Publications in Other Journals

A survey of Lyapunov's second method. H. A. Antosiewicz. Ann. Math. Studies No. 41 (Contributions to the Theory of Nonlinear Oscillations 4) 1958.

Developments in instruments. W. T. Sweeney. Intern. Dental J. **8**, No. 2, 238–250 (June 1958).

Publications for which a price is indicated are available only from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. (foreign postage, one-fourth additional). The three NBS periodicals are available on a 1-, 2-, or 3-year subscription basis, although no reduction in rates can be made. Reprints from outside journals and the NBS Journal of Research may often be obtained directly from the authors.

Patents

(The following patents were granted to NBS inventors during the past quarter (July–September 1958) and, except as noted, are assigned to the United States of America as represented by the Secretary of Commerce.)

No. 2,843,263. July 15, 1958. Wafer gager. Robert L. Henry, Jr. (Navy).

No. 2,843,541. July 15, 1958. Electrophoretic deposition of barium titanate. Seymour Senderoff and Walter E. Reid, Jr. (Army).

No. 2,844,958. July 29, 1958. Torsion fatigue testing machine for wire. John A. Bennett and Harry C. Burnett (Army).

No. 2,845,613. July 29, 1958. Phase-sampling telemeter. Myron G. Pawley.

No. 2,846,647. August 5, 1958. Microwave calorimetric wattmeter. Alan C. Macpherson.

No. 2,848,697. August 19, 1958. Plug-in packaged waveguide assembly. Robert K–F Seal.

No. 2,849,197. August 26, 1958. Servo control mechanism. Jacob Rabinow, Emmett C. Bailey, and Francis H. Shepard, Jr. (Navy).

No. 2,849,336. August 26, 1958. Method of producing boride coatings on metal. Margaret A. Reid and Abner Brenner.

No. 2,849,404. August 26, 1958. Morphotropic piezoelectric ceramics. Bernard Jaffe, Robert S. Roth, and Samuel Marzullo (Army).

No. 2,849,629. August 26, 1958. Chatter accelerometer. Charles W. Kissinger.

No. 2,852,533. September 16, 1958. Titanium borohydride complex and preparation thereof. Abner Brenner and Joseph Bish (Air Force).

No. 2,853,649. September 23, 1958. Williams memory system using a double-intensity beam. William W. Davis.

No. 2,854,626. September 30, 1958. Plating thickness indicator. Martin Davidson and Nicholas S. Rahal (Navy).

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